



How Simulation and Model Adjustments Helps Metal Casting Processes

Eva Anglada, Antton Meléndez, Iban Vicario



Simulation on metal casting industry

The use of numerical simulation in the metal casting industry has experienced a significant increase during last years

Usual simulations Quite extended

Thermal-flow + solidification

- *Gravity casting*
- *Low-pressure*
- *HPDC*
- *Sand molding*
- *Investment casting, etc.*

Advanced simulations Not usual

- **Thermal stress**
- **Microstructure prediction**
- **Advanced porosity, etc.**

Difficulties

*Obtaining reliable results in the numerical simulation of metal casting processes is difficult. **Why?***

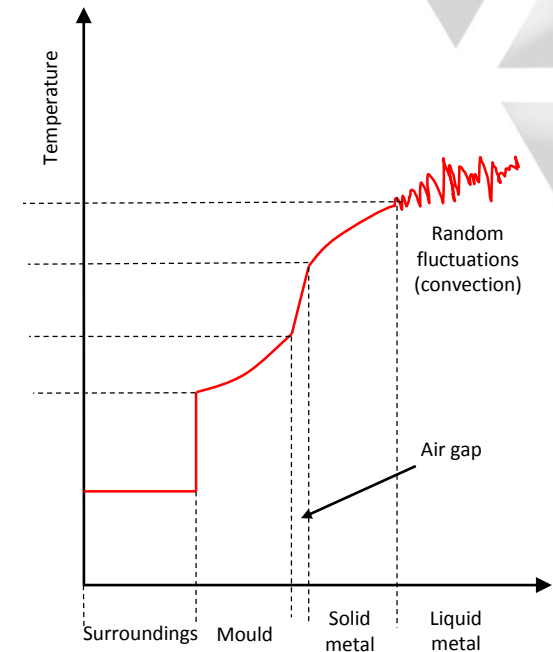
- **Material properties**

Measuring the material properties for the whole range of temperatures involved in the metal casting processes is very difficult.

Literature data generally correspond to standard values and not always provide satisfactory results.

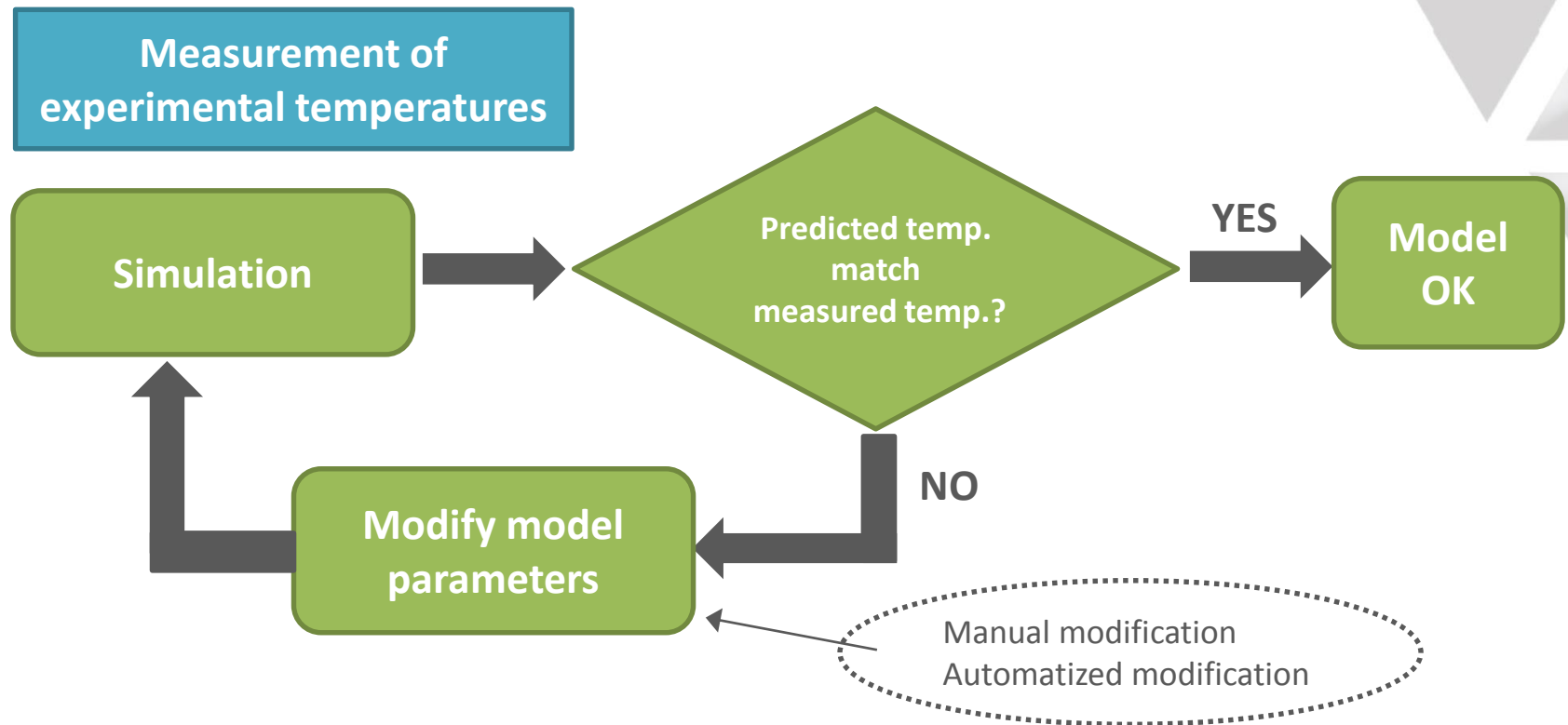
- **Heat transfer coefficients**

Determining the heat transfer coefficients is even more complex.



Solution

*These difficulties have inspired the application of **inverse modeling** to avoid them.*



Examples

Investment casting



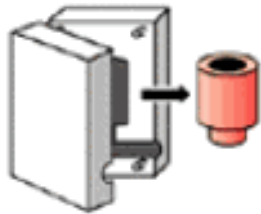
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HPDC

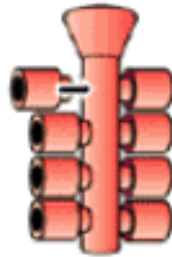


Investment casting

Flow-chart



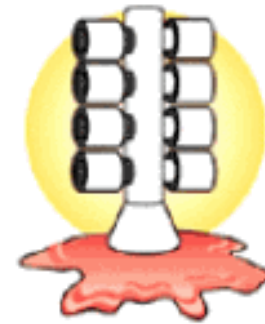
Wax injection



Assembly



Shell building



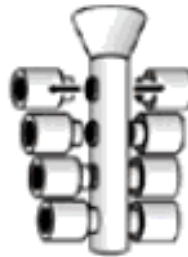
Dewax / burnout



Pouring



Knock out

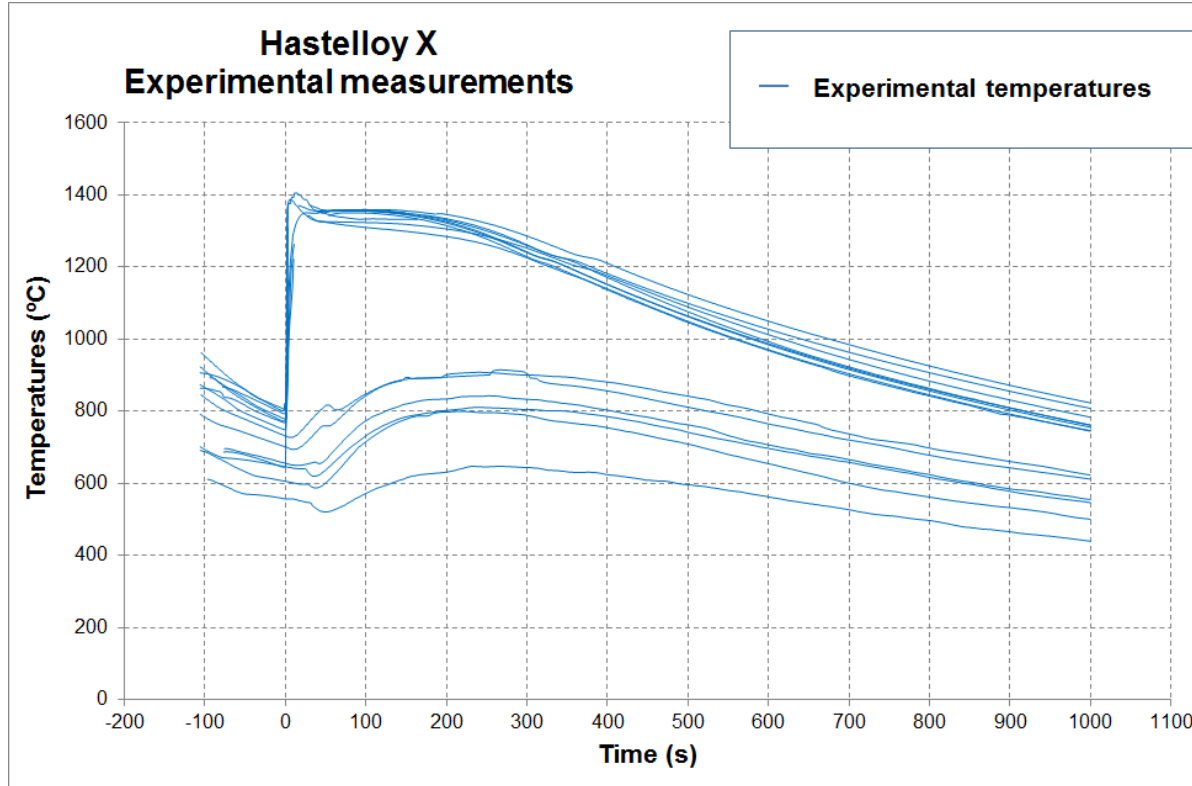


Cutt-off



Investment casting

Experimental measurements on prototype



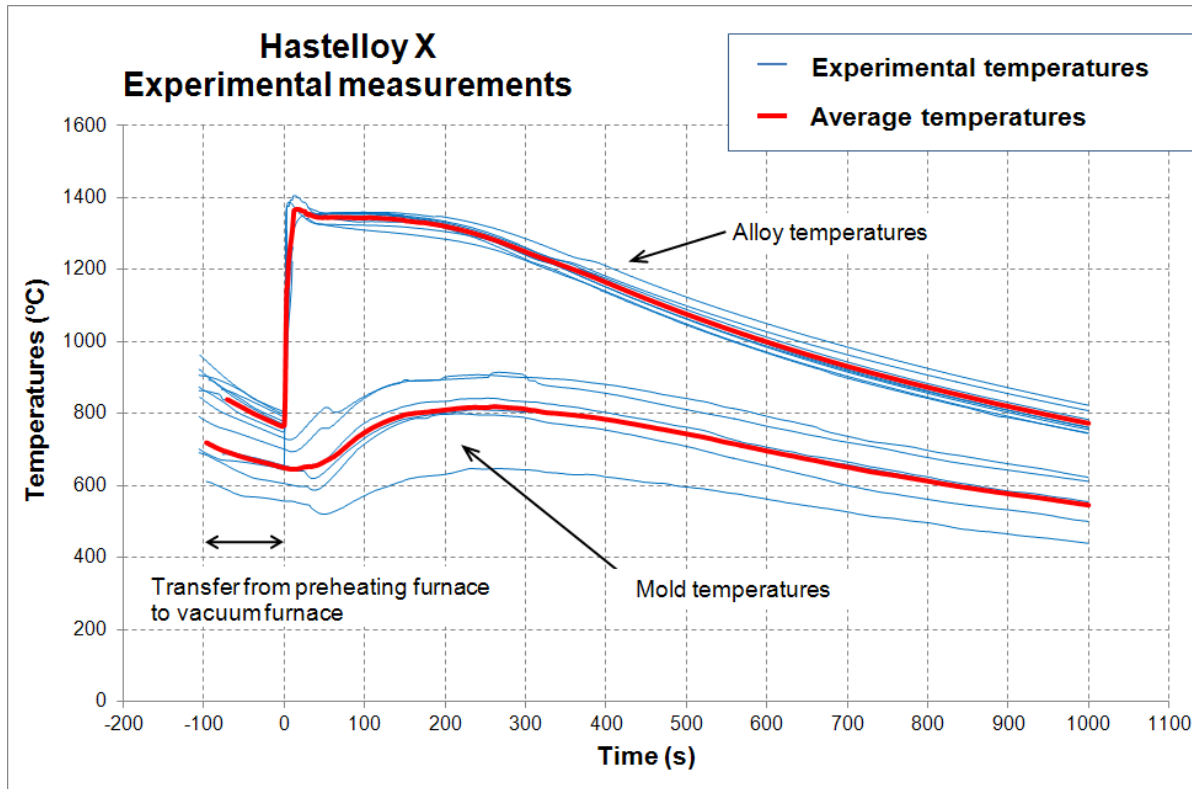
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Investment casting

Experimental measurements on prototype



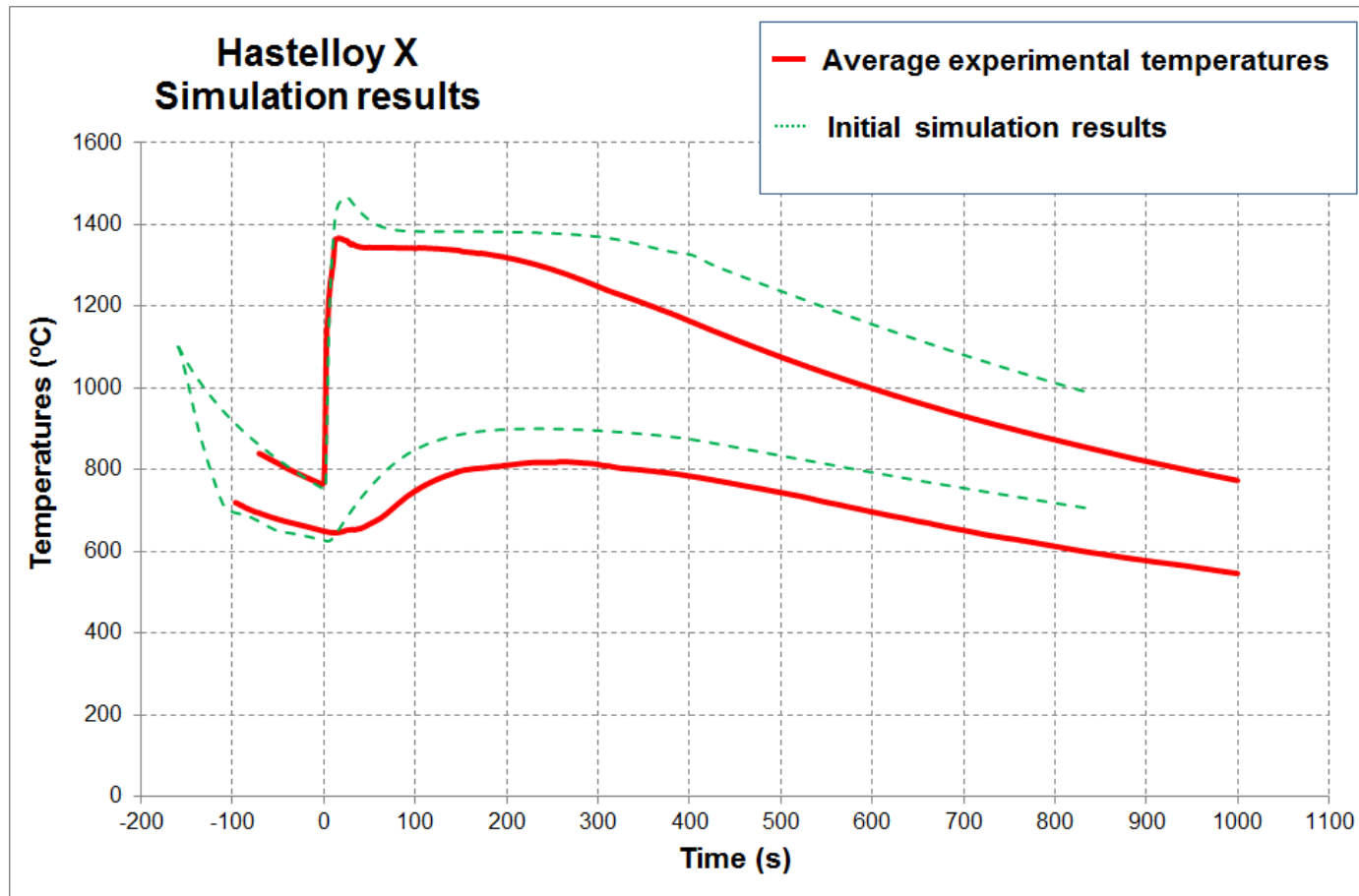
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Investment casting

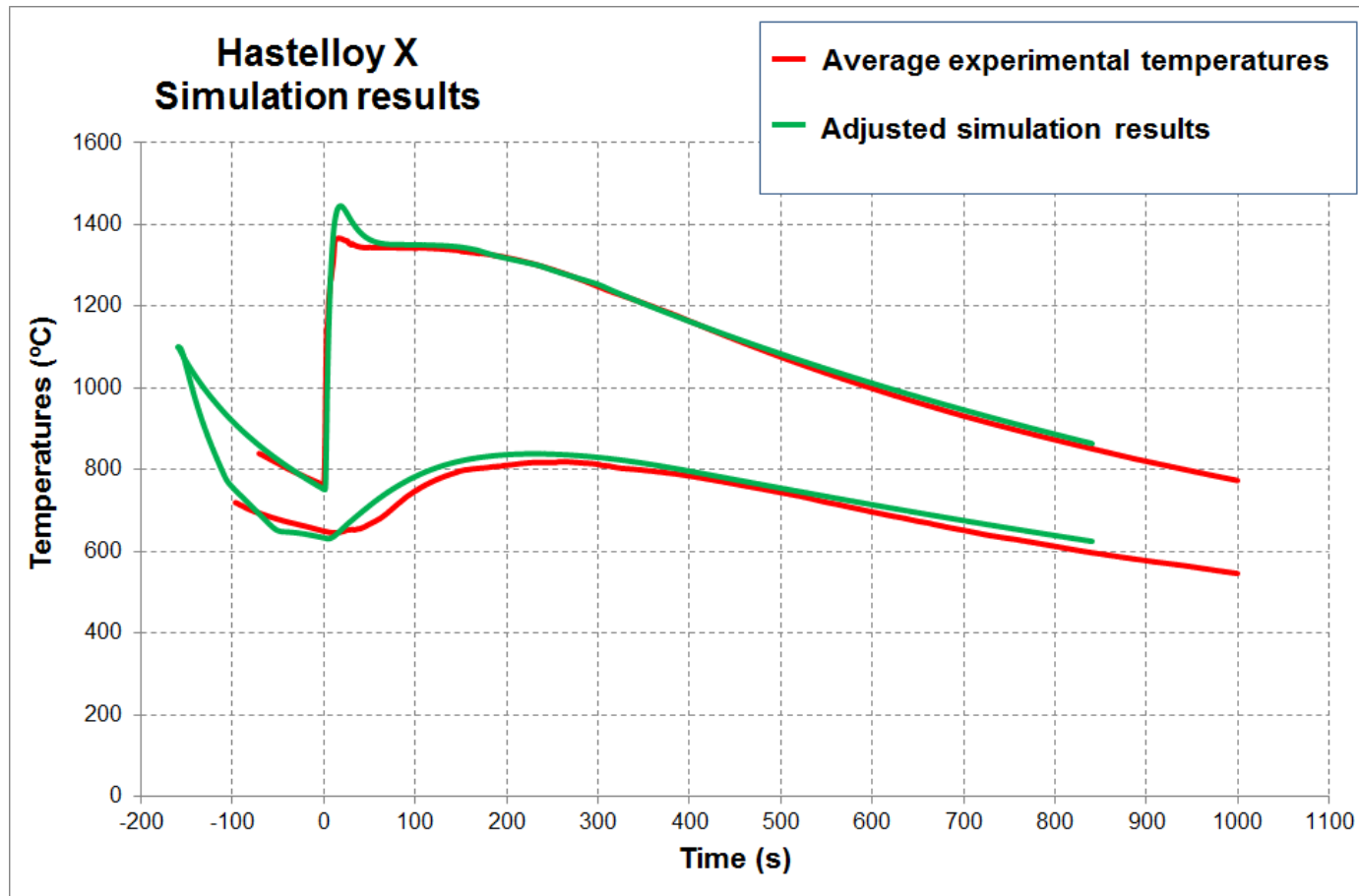
Simulation results



Source: ANGLADA, Eva; MELÉNDEZ, Antton; MAESTRO, Laura; DOMÍNGUEZ, Ignacio. Finite Element Model Correlation of an Investment Casting Process. Materials Science Forum, Vol. 797, pp 105-110.
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Investment casting

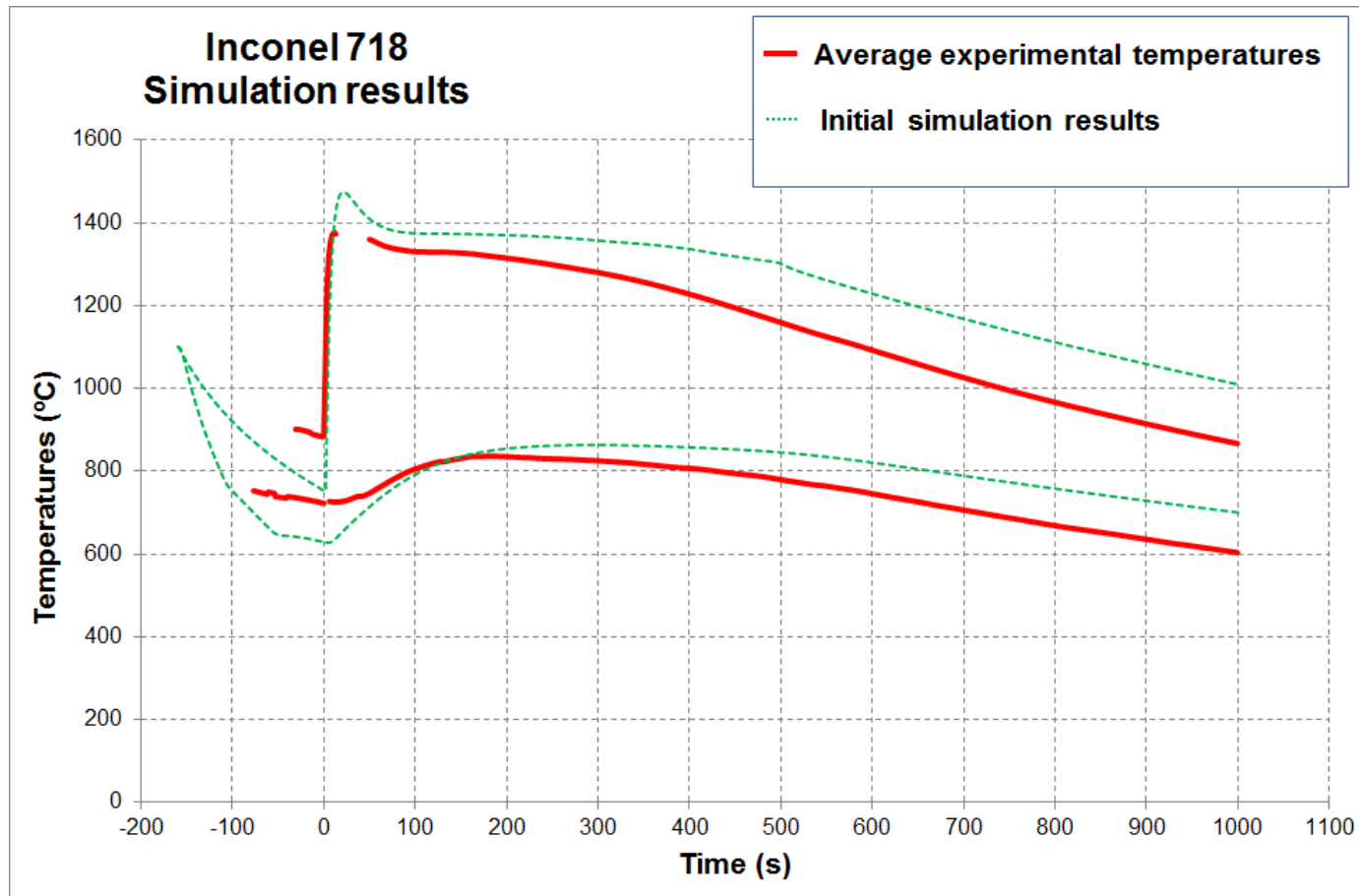
Simulation results



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Investment casting

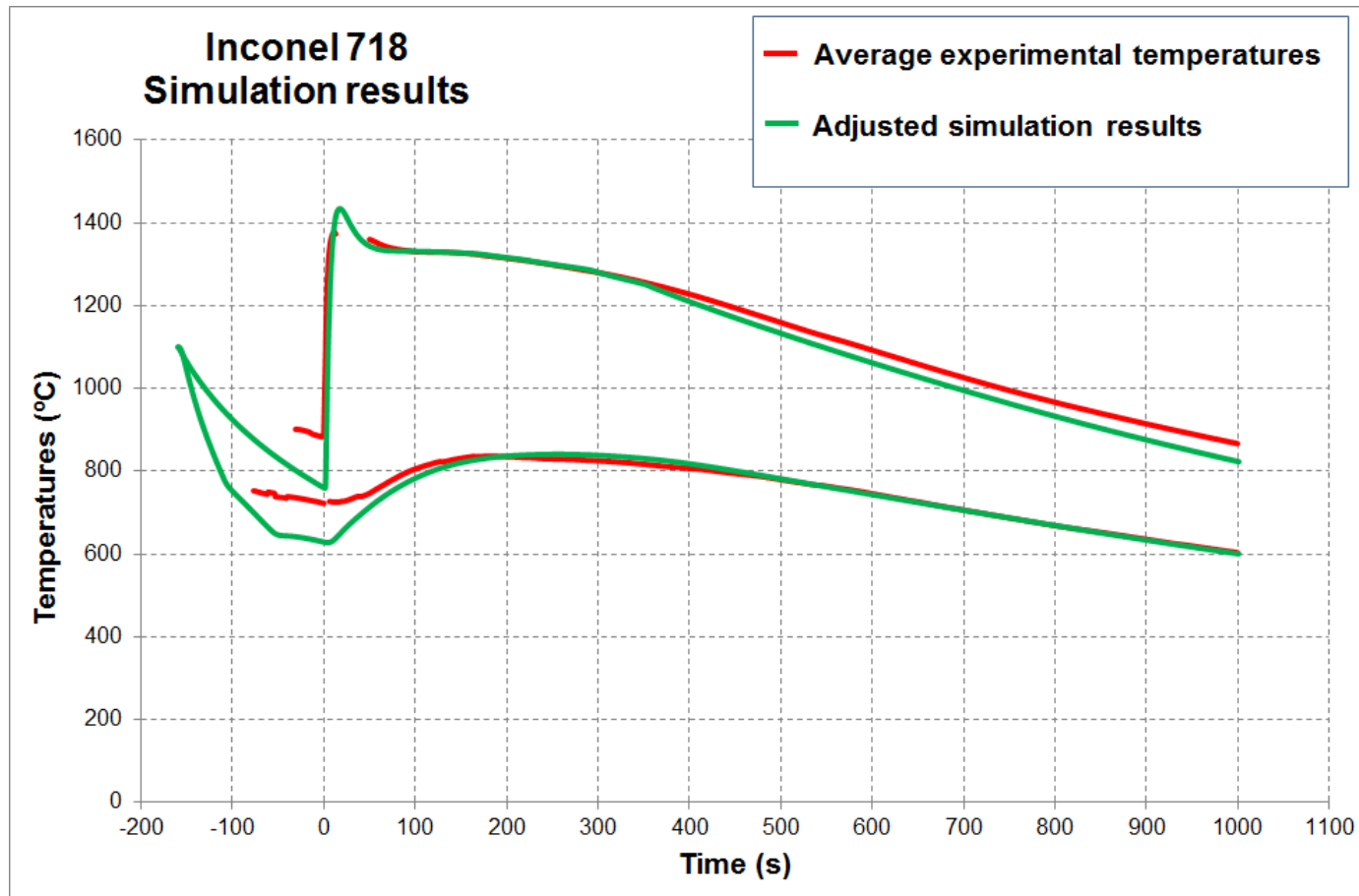
Simulation results



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Investment casting

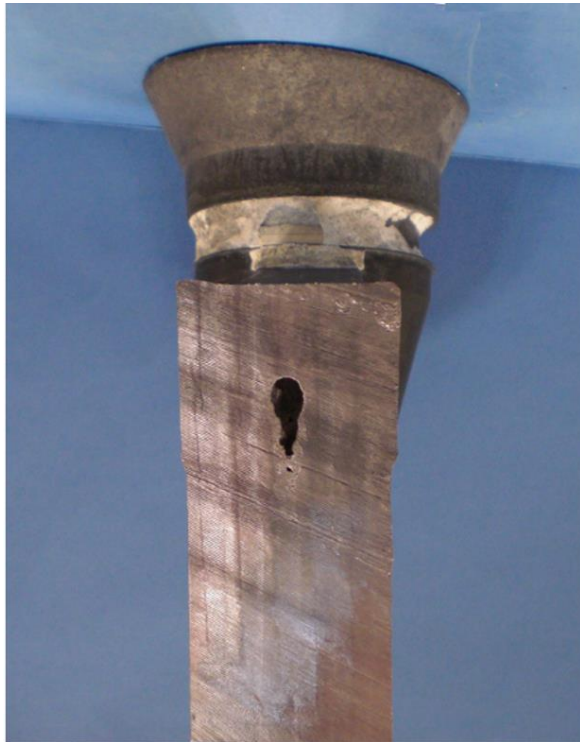
Simulation results



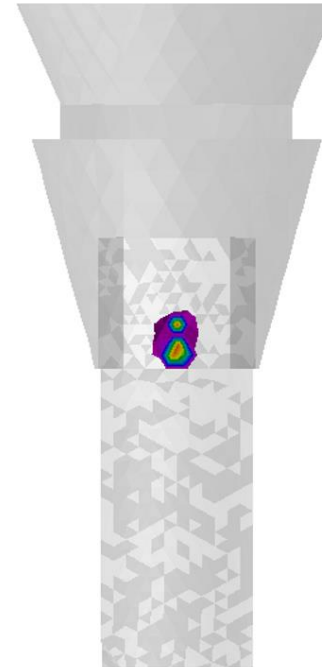
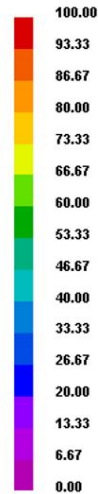
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Investment casting

Shrinkage results

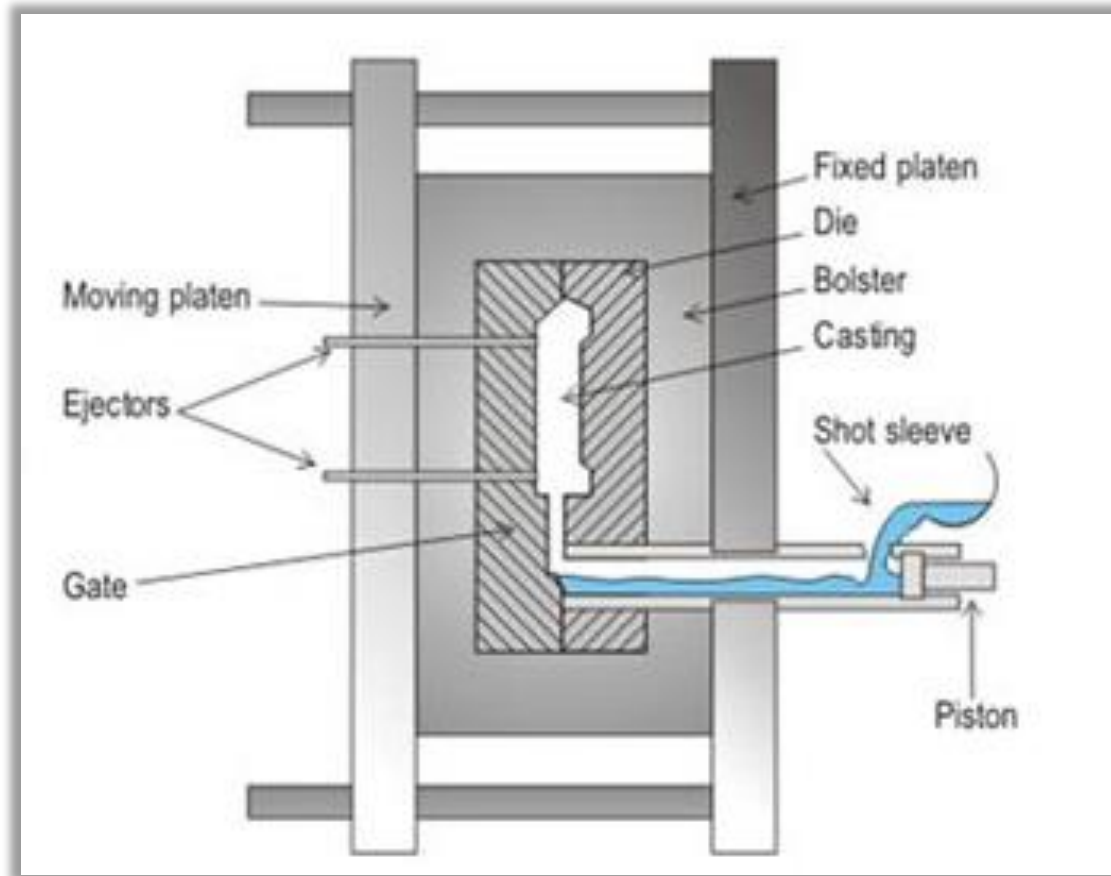


Shrinkage Porosity [%]



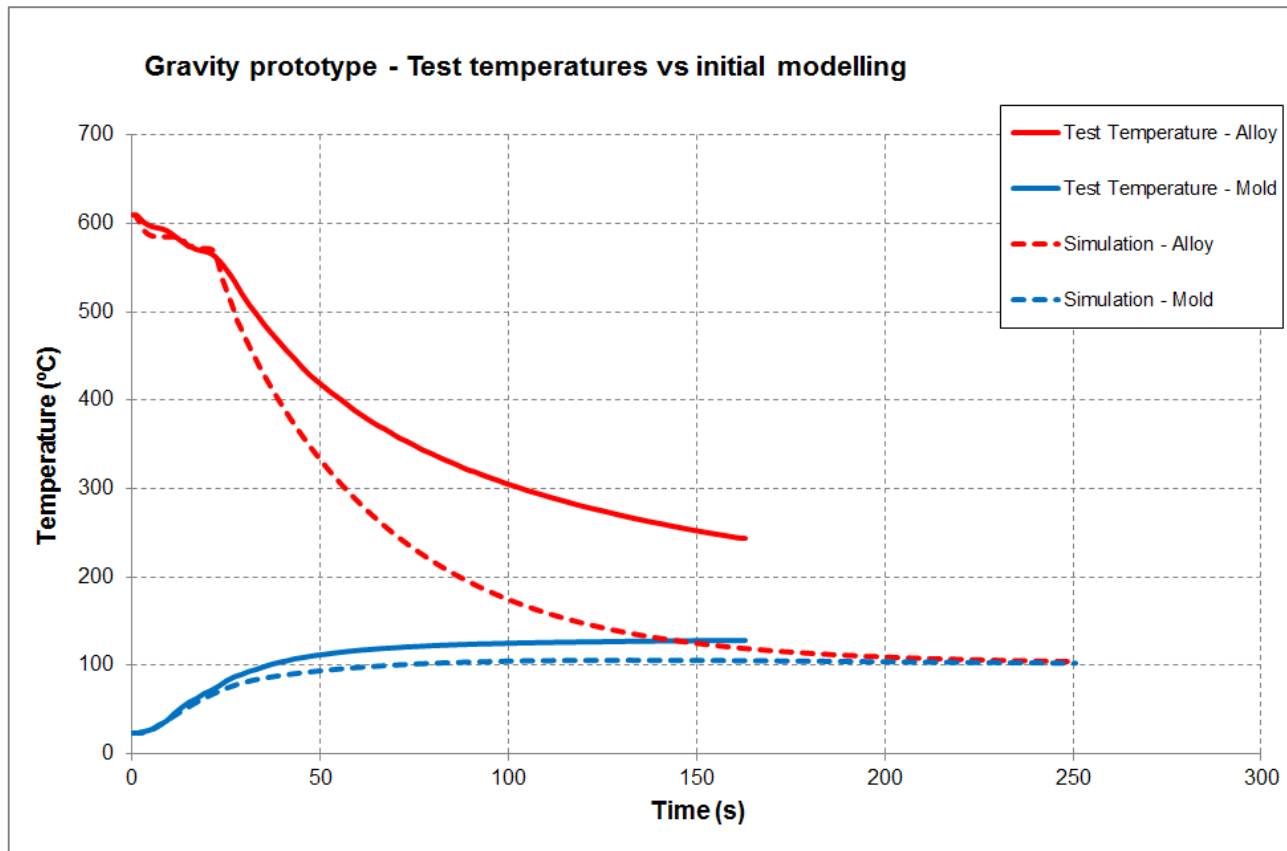
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HPDC



HPDC

Experimental measurements on gravity prototype

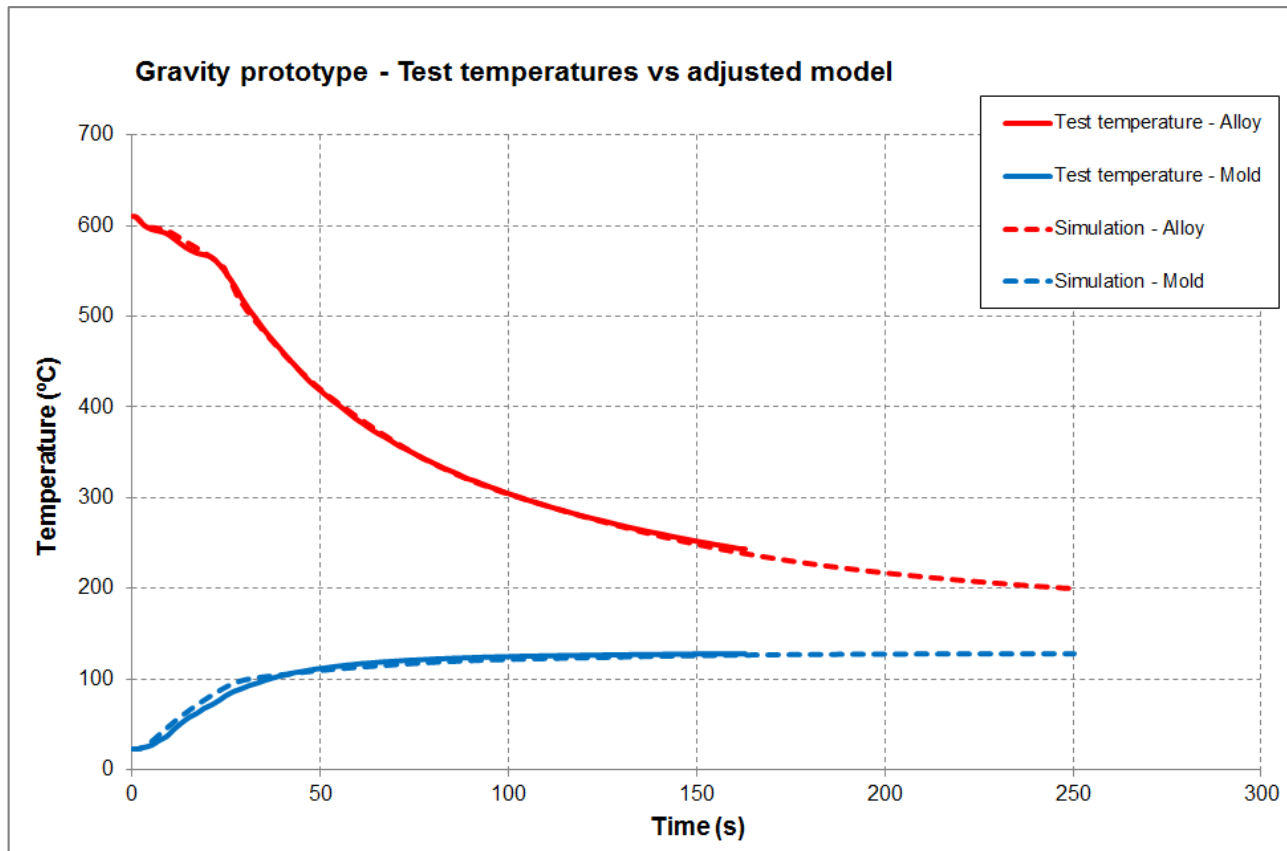


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HPDC

Experimental measurements on gravity prototype

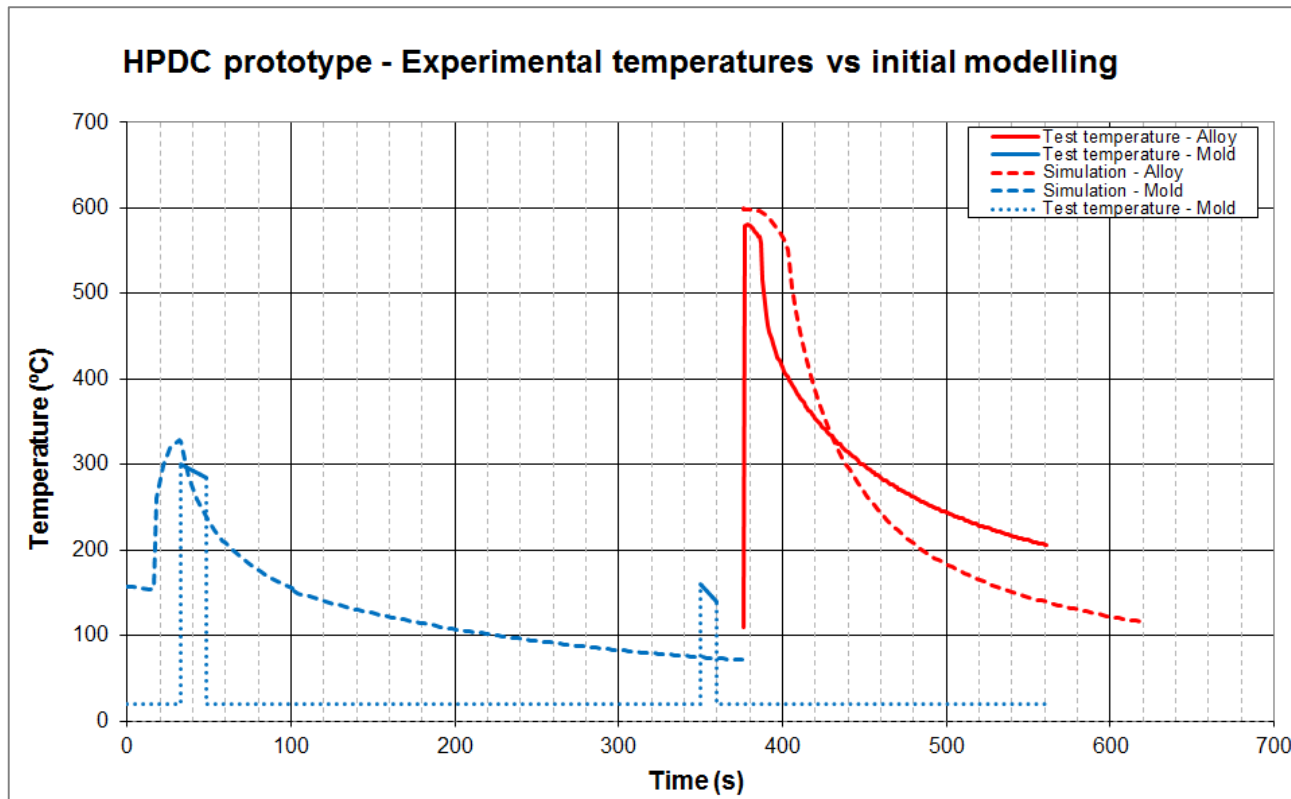


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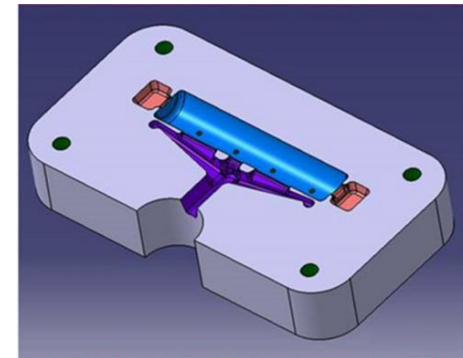


HPDC

Experimental measurements on HPDC prototype

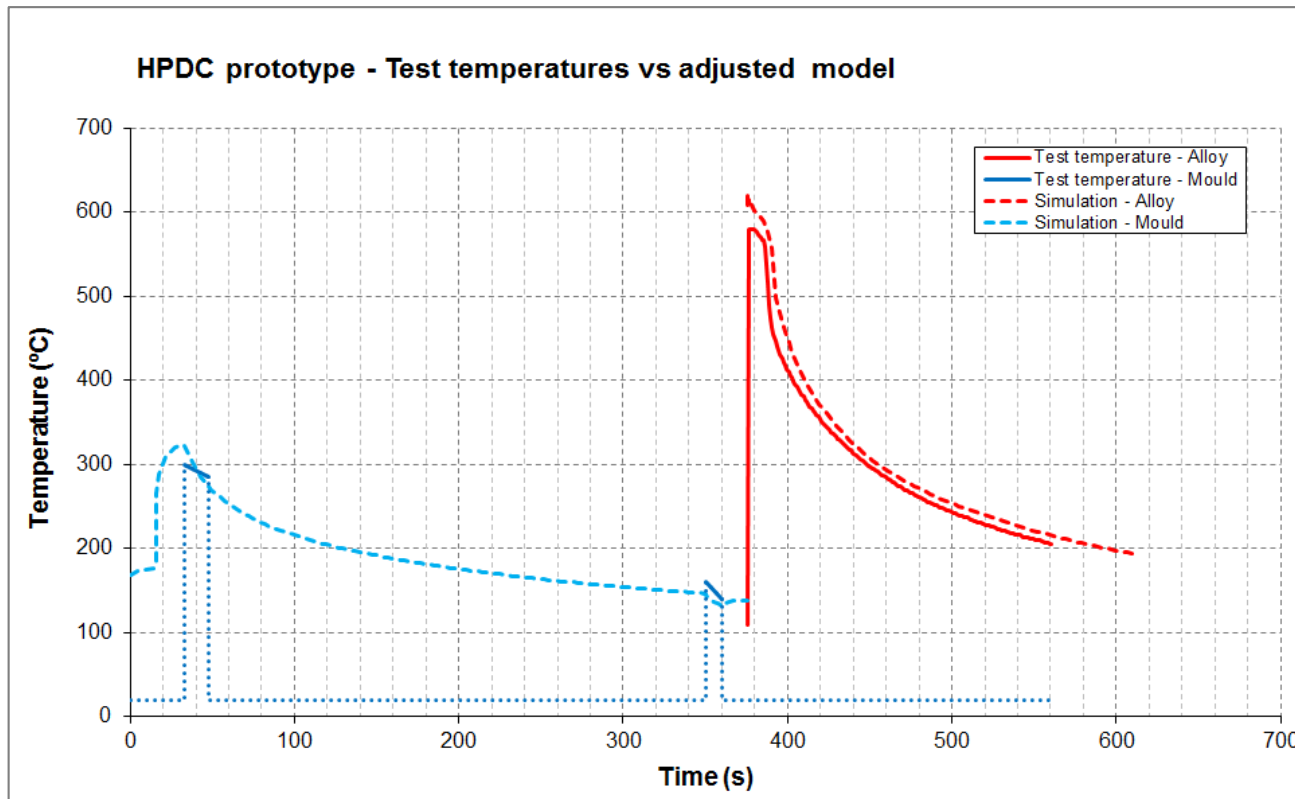


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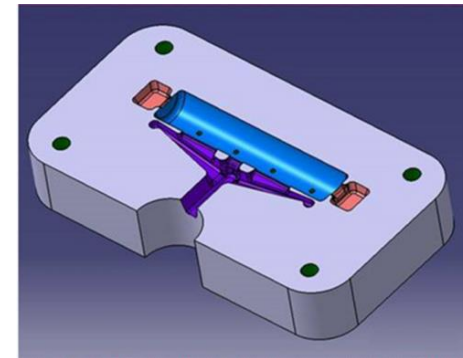


HPDC

Experimental measurements on HPDC prototype

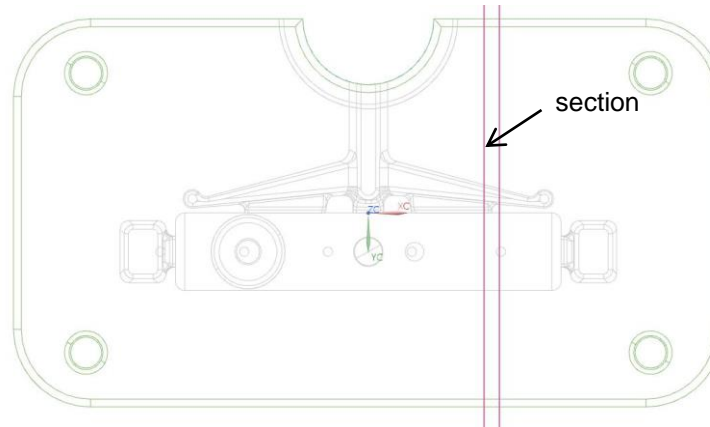
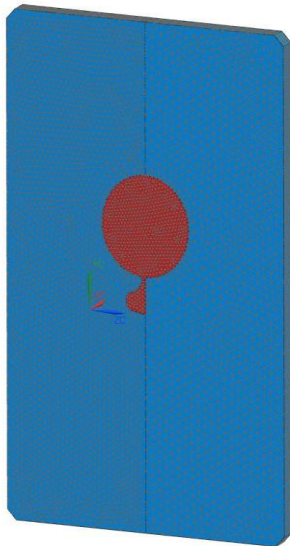


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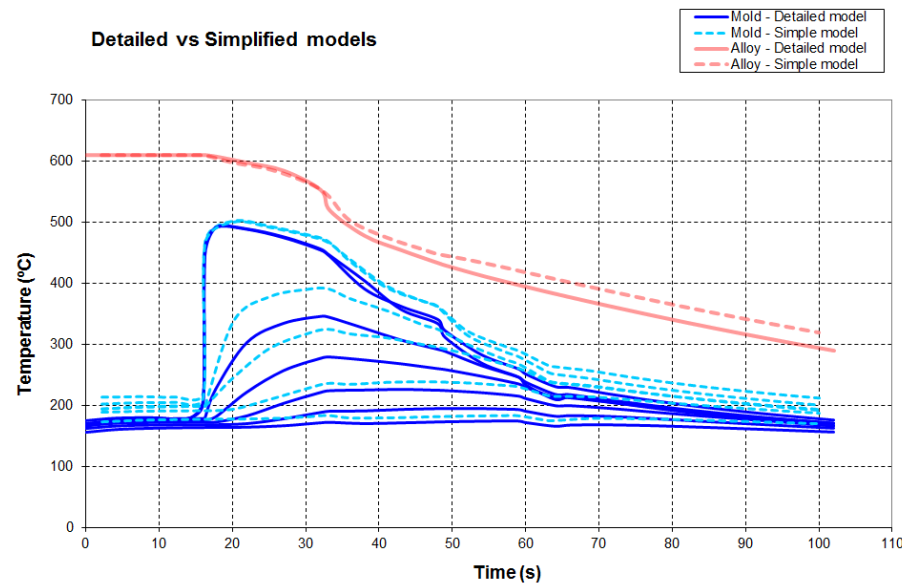


HPDC

First approximations - Simple simulation model



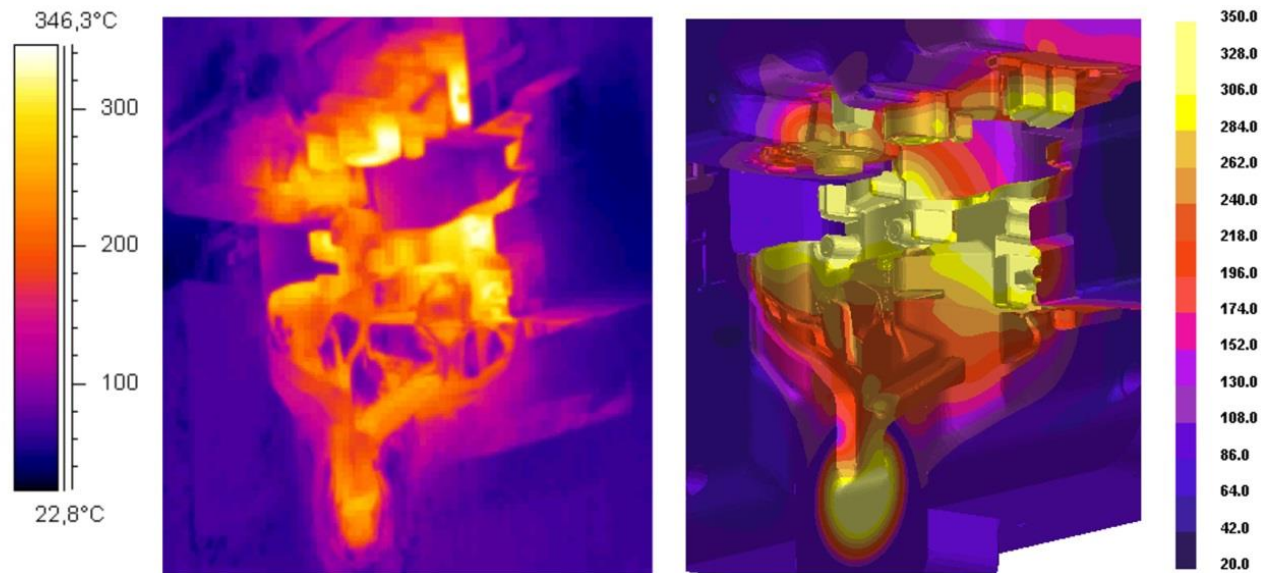
Detailed vs Simplified models



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HPDC

Validation on real HPDC part



Thank you for your attention

eva.anglada@tecnalia.com